Title: A 9-month Jumping Intervention to Improve Bone Acquisition in Adolescent Male Athletes: The PRO-BONE Study

Authors: Dimitris Vlachopoulos[1,*], Alan R. Barker[1], Esther Ubago-Guisado[1,2], Craig A. Williams[1], Luis Gracia-Marco[1,3]

[1]University of Exeter, United Kingdom.

[2]University of Castilla-La Mancha, Spain.

[3] University of Granada, Spain.

BACKGROUND: Participation in different loading sports during growth can have different effects on bone status and development. However, there is no evidence how to improve bone acquisition in adolescent athletes involved in weight-bearing and non-weight bearing sports. PURPOSE: To investigate for first time the effect of a 9-month jumping intervention programme on bone mass, geometry and microarchitecture in adolescent males participating in weight-bearing (soccer, SOC) and non-weight bearing (swimming, SWI & cycling, CYC) sports. METHODS: 93 adolescent males (13-15 years) were included. Sport groups were randomised to intervention and sport (INT-SWI=19, INT-SOC=15, INT-CYC=14) or sport only (CON-SWI=18, CON-SOC =15, CON-CYC=12). The intervention comprised a progressive jumping programme of 3 levels (3 months each) using weighted vests (Level 1= 20 jumps, 0 kg, 3 sets/day, 3 times/week; Level 2= 20 jumps, 2 kg, 4 sets/day, 3 times/week; Level 3= 20 jumps, 5 kg, 4 sets/day, 4 times/week). Dual-energy x-ray absorptiometry (DXA) assessed bone mineral content (BMC), hip structural analysis (HSA) assessed cross-sectional area (CSA), cross-sectional moment of inertia (CSMI) and section modulus, trabecular bone score (TBS) assessed bone microarchitecture and quantitative ultrasound assessed bone stiffness before and after the intervention. One-way analysis of covariance compared the bone gains after controlling for pre-intervention bone, change in lean mass and post maturity status. Significance was set at $p<0.05$. RESULTS: INT-CYC gained significantly ($p<0.05$) higher total body less head BMC (5.0 %), lumbar spine BMC (4.6 %), femoral neck BMC (9.8 %) and bone stiffness (12.3 %) than CON-CYC. INT-CYC gained significantly higher CSA (11.0 %), CSMI (10.1 %) and TBS (4.4 %) outcomes than CON-CYC. INT-SWI gained significantly ($p<0.05$) higher femoral neck BMC (6.0 %), legs BMC (4.2 %) and bone stiffness (12.7 %) than CON-SWI. INT-SWI gained significantly ($p<0.05$) higher CSMI outcomes (10.9 %) than CON-SWI. There were no significant ($p>0.05$) differences between INT-SOC and CON-SOC for any bone outcomes (0.9-3.9 %). CONCLUSIONS: The present 9-month jumping intervention improved bone outcomes in non-weight bearing sports, such as swimming and cycling, but not in a weight-bearing sport, such as soccer.